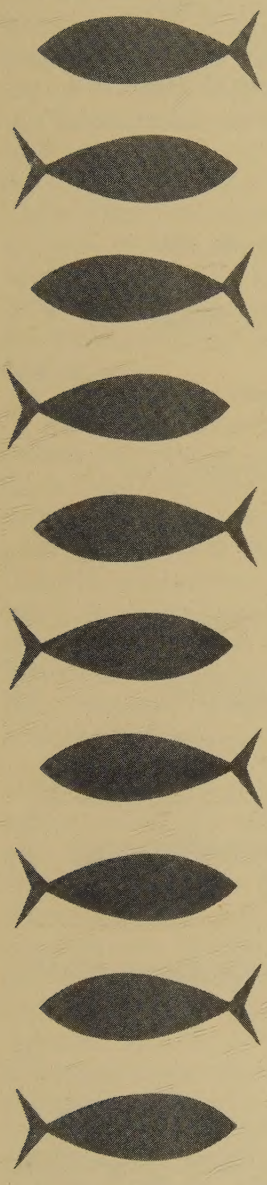
Southwest FISHERIES SCIENCE CENTER

HONOLULU LA JOLLA MONTEREY TIBURON

REPORT OF ACTIVITIES Third Quarter 1995



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ANTARCTIC ECOSYSTEM RESEARCH GROUP

La Jolla, California

CCAMLR Working Group Meeting

Some years ago, the Scientific Committee of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) established working groups on krill and the CCAMLR Ecosystem Monitoring Program. These groups have met annually to discuss pertinent CCAMLR issues, particularly those relating to harvested and krill-dependent Antarctic species, their interactions, the nature of harvesting, and the influences of environment on the Antarctic ecosystem. A substantial time series of information has been collected by the working groups since the mid-1980s, resulting in a highly improved understanding of ecosystem components. In 1991, the Scientific Committee decided to begin integrating the two working groups and in 1994, the committee established a combined group, the Working Group on Ecosystem Monitoring and Management.

The 1995 meeting of the Working Group on Ecosystem Monitoring and Management was held in Siena, Italy, from July 24 to August 3, 1995. The U.S. delegation at the meeting included Fishery Biologists Rennie Holt and Roger Hewitt (Southwest Fisheries Science Center, [SWFSC]), Ocean Acoustic Engineer David Demer (SWFSC), Gerry Kooyman (Scripps Institution of Oceanography), Wayne Trivelpiece (Montana State University), Polly Penhale (National Science Foundation), and Valerie Loeb (Moss Landing Marine Laboratories).

Members of the U.S. delegation, along with other non-attending U.S. scientists, submitted many papers for discussion at the meeting, including: "Uncertainty in standard sphere calibrations," by D. Demer and R. Hewitt; "Acoustic survey design to estimate krill biomass in subareas 48.1, 48.2 and 48.3," by George Watters (fishery biologist, SWFSC) and R. Hewitt; "Uncertainty in acoustic surveys of Antarctic krill," by D. Demer; "Comparing a model of krill population dynamics and recruitment data," by Marc Mangel (University of California, Davis); "Changes in Adelie penguin recruitment: correlations to krill biomass estimates and implications for fisheries management in the Southern Ocean," by Wayne Trivelpiece and Susan Trivelpiece (Montana State University); "Variability in sea ice coverage and long-term change in the diets of Adelie penguins: implications for Southern Ocean ecosystem studies," by William Fraser (Montana State University) and Wayne Trivelpiece; "Krill-ice-penguin interactions: a modelling study," by Eileen Hofmann (Old Dominion University) and Wayne Trivelpiece; and "AMLR 1994/95 field season report - objectives, accomplishments and tentative conclusions" by USA delegation, edited by Jane Rosenberg (fishery biologist, SWFSC).

Two collaborative papers between U.S. scientists and scientists from other nations also were submitted: "Recruitment of Antarctic krill (*Euphausia superba*) and possible causes for its variability," by V. Siegel (Bundesforschungsanstalt für Fischerei Institut für Seefischerei, Germany) and V. Loeb; and "Importance of myctophid fish distributions for formation of foraging areas of chinstrap penguins and Antarctic fur seals at Seal Island," by T. Ichii, T. Takao (both of National Research Institute of Far Seas Fisheries, Japan), J. Bengtson, P. Boveng, J. Jansen, L. Hiruki, W. Meyer, M. Cameron (all of National Marine Mammal Laboratory [NMML]), M. Naganobu, S. Kawaguchi and T. Ogishima (all of National Research Institute of Far Seas Fisheries, Japan). (J. Rosenberg, 619-546-5600)

Collaborative Study between SWFSC and AKFSC

During September, Hewitt and Rosenberg participated in a collaborative research cruise aboard the NOAA ship *Surveyor* with scientists from the Pacific Marine Environmental Laboratory (PMEL), the Alaska Fisheries Science Center (AFSC), NMML, and University California, Irvine. Dr. Jim Overland (PMEL) was the chief scientist for the project, called the Fisheries Oceanography Cooperative Investigation, which was conducted in the vicinity of the Pribilof Islands in the Bering Sea.

The study was focused on factors that regulate the recruitment of juvenile walleye pollock. The main objective was to elucidate horizontal and vertical distributions of juvenile pollock in relation to physical conditions such as temperature, density and light, as well as biotic influences such as prey densities, jellyfish abundance, and predator distribution. Hewitt and Rosenberg conducted acoustic surveys with the Antarctic Ecosystem Research Group's (AERG) Simrad EK500 system to examine the vertical distribution of juvenile pollock and prey. In conjunction with these surveys, AFSC personnel used Tucker trawls and other net systems to collect juvenile pollock and prey items. Several oceanographic fronts in the study area, which form between shelf water and deep water, were de-

scribed using conductivity-temperature-depth deployments. Hewitt reported that the AERG's acoustic system worked well, revealing distinct layers of juvenile pollock on both sides of the oceanographic fronts. (J. Rosenberg, 619-546-5600).

COASTAL FISHERIES RESOURCES DIVISION

La Jolla, California

Historical Trends in California's Salmon Fishery

The Central Valley Project Improvement Act mandates changes in management of the Central Valley Project for the protection and restoration of fish and wildlife. The act also requires that the U.S. Fish and Wildlife Service (USFWS) prepare a report to Congress describing the effects of the decline in anadromous stocks on the fisheries and fishing communities of California. For purposes of the report, USFWS contracted with the California Department of Fish and Game to do the biological analysis, with Industry Economists Cindy Thomson and Ken Sakoi of SWFSC for the economic analysis, and with several consulting firms for the social analysis.

Thomson and Sakoi have completed a draft analysis of the commercial, sport, and Indian fisheries for Central Valley salmon. In addition to examining historical trends in effort, harvest, prices, and value, the report also includes a 25-year profile of the commercial salmon fishing and processing sectors and a critical review of the salmon economics literature. Some highlights of the report are given here.

Ocean commercial landings: Ocean commercial landings of salmon in California (Fig. 1) averaged 4.5 million pounds per year during 1916-1943, then increased to an annual average of 7.3 million pounds during 1944-1982. Since 1983 the fishery has experienced record high and low landings. Landings in 1983 (the most severe El Niño year of the century) totalled 2.4 million pounds, the lowest harvest since 1939. Landings subsequently increased in 1989 to a record high of 14.8 million pounds, then declined in 1992 to a new record low of 1.6 million pounds. Although landings increased in 1993 to 2.6 million pounds, 1993 remains one of the lowest landings years in the history of the fishery (rivaled only by 1938-1939, 1983, and 1992). The highly variable landings experienced in recent years have been largely attributed to environmental factors (e.g., the 1986-1992 drought, severe El Niño conditions).

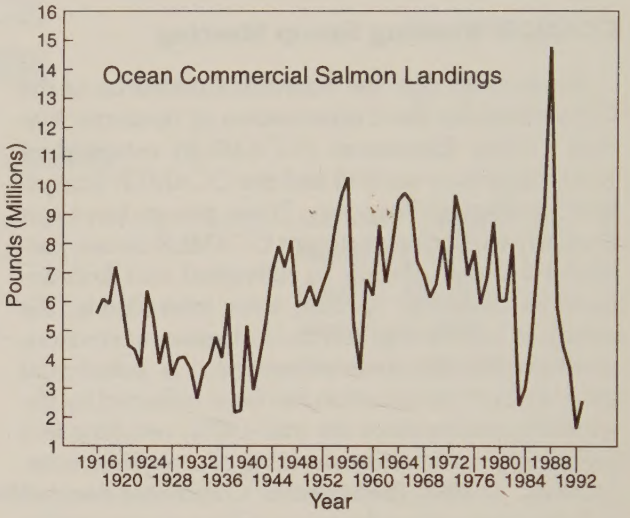

Figure 1. Ocean commercial salmon landings in California, 1916-93.

Ex-vessel prices: Ex-vessel salmon prices (Fig. 2) were on a generally upward trend since 1941 until the late 1970s but have been on a downward spiral since 1988. The vessel operators' negotiating position with processors has weakened over time, as imported farmed fish has become an increasingly important alternative source of supply for processors. The 1993 price of $2.26 per pound was the lowest since 1971.

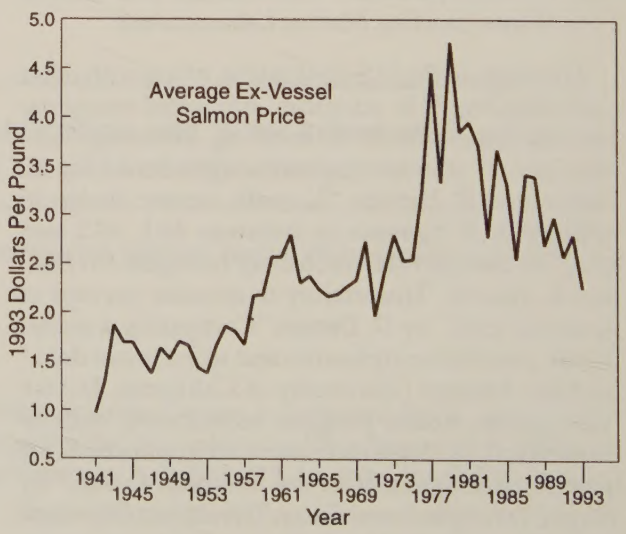

Figure 2. Average ex-vessel salmon price, 1941-93.

Commercial fleet size: During 1969-1993, an annual average of 2,909 commercial fishing vessels (about one-half of all vessels fishing in California) landed salmon. The number of salmon vessels increased from 2,125 in 1969 to a record high of 4,919 in 1978, then declined to record lows of 1,093 in 1992 and 1,239 in 1993. The average annual number of vessels participating in the salmon fishery was about 60% lower during 1992-1993 than 1969-1993 (Table 1). Since the state implemented its salmon limited-entry program in 1982, an annual average of 77% of all California fishing vessels have held limited-entry permits and 63% of all permit holders have actually landed salmon. The number of permit holders in 1993 was 2,740, a 54% reduction from the 5,964 vessels that held permits at the inception of the program. Factors contributing to the decline in the number of permit holders and the number of vessels landing salmon include adverse fishing conditions and restrictions on the issuance of new permits.

Table 1. Number of salmon vessels in California by vessel category and percentage of total ex-vessel salmon revenue in California accounted for by each vessel category, by year.

	1969-1993 Avg.		1992		1993	
Vessel Category[1]	# Boats	% Rev	# Boats	% Rev	# Boats	% Rev
<$5000; ≥95%	1,333	10%	427	13%	524	12%
<$5000; <95%	566	5%	370	12%	328	8%
>$5000; ≥95%	526	38%	147	36%	203	41%
>$5000; <95%	484	47%	149	39%	184	38%
Total	2,909	100%	1,093	100%	1,239	100%

[1]Categories defined in terms of whether annual salmon revenue per vessel was more or less than $5,000 and whether salmon contributed more or less than 95% of a vessel's total revenue.

Table 2. Average annual ex-vessel revenue per salmon vessel from all species and percentage contribution of salmon to total revenue, by vessel category and year.

	1969-1993 Avg.		1992		1993	
Vessel Category[1]	Dollars	% Sal	Dollars	% Sal	Dollars	% Sal
<$5000; ≥95%	1,402	99%	1,377	99%	1,387	99%
<$5000; <95%	49,215	3%	16,508	9%	19,307	8%
>$5000; ≥95%	14,303	99%	11,544	99%	11,907	99%
>$5000; <95%	68,249	38%	26,941	45%	32,471	37%

[1]Categories defined in terms of whether annual salmon revenue per vessel was more or less than $5,000 and whether salmon contributed more or less than 95% of a vessel's total revenue.

Commercial fleet characteristics: The salmon fleet consists of a large number of small operators. Annual salmon revenue varies widely among vessels, both in absolute amount and as a percentage of total revenue from all species. For purposes of analysis, Thomson and Sakoi characterized salmon vessels according to the following four categories: (1) <$5000 and ≥95% , (2) <$5000 and <95%, (3) >$5000 and ≥95%, and (4) >$5000 and <95%. Each category was defined in terms of whether annual salmon revenue per vessel was more or less than $5,000 and whether salmon contributed more or less than 95% of a vessel's total revenue from all species.

In Table 1, the distribution of salmon vessels by vessel category is described as well as the percentage of total ex-vessel salmon revenue in California accounted for by each of the four categories. Of the 2,909 vessels that participated in the salmon fishery on an average annual basis during 1969-1993, 1,010 vessels (36%) fell into categories 3 and 4, that is, earned more than $5,000 per year from salmon. These vessels accounted for a disproportionate 85% of total salmon harvest and ex-vessel revenue from the California fishery.

In Table 2, the average annual ex-vessel revenue per boat from all species and the percentage of average revenue per boat attributable to salmon are presented. These dollar estimates pertain only to revenues derived from California fisheries. Some vessels may also derive income from fishing outside of California or from non-fishing occupations.

During 1969-1993, vessels in both categories 1 and 2 (<$5000 and ≥95%, and <$5000 and <95%) earned an average of $1,400 annually from salmon, but were at opposite ends of the spectrum in terms of the contribution of salmon to total ex-vessel revenues (99% and 3%, respectively). Vessels in the <$5000 and <95% category tend to land salmon incidentally while targeting other species. Those in the <$5000 and ≥95% category were largely sport fishers that fished commercially on occasion.

Vessels in the remaining two categories earned significantly higher annual incomes from salmon

($14,160=$14,303*99% for the >$5000 and ≥95% category and $25,935=$68,249*38% for the <95% [>$5000] category). Vessels in the >$5000 and ≥95% category tend to fish in California only during the salmon season but may also fish outside the state or have operators employed in non-fishing occupations during the off-season (e.g., school teachers). Vessels in the >$5000 and <95% category tend to be year-round fishers earning about 38% of their annual income from salmon and the remainder from crab, albacore, and other species.

For vessels in the >$5000 and ≥95% category, average annual revenue from all species was about 20% lower during 1992 and 1993 than 1969-1993. For vessels in the >$5000 and <95% category, the decline was an even more drastic 50%. For vessels in this latter category, the contribution of salmon to total ex-vessel revenue was not appreciably different in 1992 (45%) and 1993 (37%) than it was during 1969-1993 (38%). This fact, combined with the absolute decline in total ex-vessel revenue per boat from all species, suggests that earnings from alternative fisheries (not just salmon) have declined in recent years.

Alternative fishing opportunities for the commercial fleet: Alternative fishing opportunities for salmon trollers in the albacore, crab, and groundfish fisheries have become more limited in recent years: (1) Since about 1980, albacore have not been widely distributed within 50 miles of the Pacific coast and therefore have not been available to west coast salmon trollers, which tend to have a more limited offshore range than the larger albacore trollers. (2) In 1992, the State of California began requiring a permit for entry into the Dungeness crab fishery. The state's temporary moratorium on new entrants to the crab fishery, which expired in January 1995, was replaced by a limited-entry program in April 1995. Limited-entry permits are not transferable. (3) The Pacific Fishery Management Council implemented a limited-entry program for groundfish in 1991. Salmon vessels can participate in the hook-and-line rockfish segment of the groundfish fishery, which remains an open-access fishery with trip limits.

Vessels in the >$5000 and <95% category have experienced significant short-run losses associated with recent downturns in non-salmon as well as salmon fisheries. However, over the long run, these vessels are in a relatively good position to take advantage of favorable changes in species availability or markets, since they already have the necessary gear, experience, and permits to participate in a variety of fisheries.

Vessels in the >$5000 and ≥95% category are in a more tenuous position in the long run, since their near exclusive reliance on salmon fishing has essentially locked them out of other fishing opportunities. New entry into the crab fishery is not possible at this time. Even if it were, a $45,000 investment in gear would be needed and bank loans are generally not available. Individual operators desiring to leave fishing altogether will likely receive a low price for their boats (the depressed capital market being reflective of current fishery conditions). Switching to a non-fishing occupation may also be difficult, given the high unemployment rates and narrow economic base in many fishing communities.

Ocean sport fishery: Ocean salmon recreational effort averaged 189,019 angler days per year during 1962-1993. About 10% of fishing effort occurred in Crescent City, 16% in Eureka, 8% in Fort Bragg, 50% in San Francisco, and 16% in Monterey. Total salmon angler expenditures averaged $14.1 million per year over this same period.

Inriver sport fishery: Historical data on salmon effort and harvest in the inland sport fishery are somewhat sketchy. Available data for fiscal years 1990/1991 through 1993/1994 indicate that salmon fishing effort on the Sacramento, Feather, and American Rivers averaged 131,270 angler days per year. Total angler expenditures by the anglers averaged $5.9 million per year over this same period.

Indian fishery: The Indian commercial fishery, which began as early as 1876, was shut down in 1933 when the State of California banned the use of gillnets on the Klamath River. Additional state efforts to regulate the Indian fishery culminated in a 1975 court decision which held that the state had no authority to regulate Indian fishing on the reservation. The Hoopa-Yurok Settlement Act of 1988 gave the Hoopa Indians timber rights on the reservation and 10% of the Indian share of the Klamath harvest for subsistence and ceremonial needs; the Yuroks received the remaining 90% share of fishing rights. The Indians harvested 46,000-54,000 salmon annually during 1987-1989, over half of which was designated for commercial use. However, the 6,000-10,000 fish harvested annually since 1989 have not been adequate to meet even subsistence and ceremonial needs, much less support a commercial fishery.

The USFWS draft report describing the effects of the decline in anadromous stocks on the fisheries and fishing communities of California has been dis-

tributed for public review. The final report will be delivered to Congress by the end of the year. At that time, Thomson and Sakoi's economic analysis also will be distributed as a separate NMFS publication. (C. Thomson, 619-546-7116)

Using Genetic Techniques to Identify Larval Rockfishes

The Coastal Fisheries Resources Division has been developing techniques for genetic identification of larval rockfishes. The genetic sequences of a fish can be as diagnostic of a species as more traditional morphological characteristics such as the number of fin rays. The primary challenge for the molecular systematist is finding regions of DNA that are variable between species but similar within individuals of the same species. Although direct sequencing of DNA can be expensive and time consuming, it is invaluable for resolving specific taxonomic questions concerning larval identification. Fisheries scientists would also like to be able to identify large numbers of field samples that may contain many individuals of different species. In this case, cost and time become important factors, and simplifying the analysis procedure becomes a priority.

Rockfishes of the genus *Sebastes* form a highly diverse complex of over 100 species, approximately 72 of which occupy widely overlapping geographic ranges in the northeastern Pacific. They support valuable commercial and recreational fisheries and are the subject of research and management interest by state and federal fisheries agencies. Although larval fish surveys are routinely conducted by both the Tiburon and La Jolla Laboratories, the estimation of population sizes for rockfishes by quantification of larval abundances has been hampered by the difficulties in assigning a positive identification to many of the rockfish species. As an example, rockfish larvae that could be identified only to genus (*Sebastes* sp.) were second in ranked occurrence and fourth in ranked abundance among larval fish taxa collected during California Cooperative Fisheries Investigations (CalCOFI) survey cruises between 1951 and 1984.

To begin to address the problem of larval identification by genetic means, a subset of *Sebastes* species was picked, consisting of widow rockfish (*S. entomelas*), yellowtail rockfish (*S. flavidus*), black rockfish (*S. melanops*), blue rockfish (*S. mystinus*), and olive rockfish (*S. serranoides*). This group was of particular interest to scientists at the Tiburon Laboratory. Pelagic juveniles of these species form a coherent group characterized by the presence of a black pigment blotch at the posterior of the spinous dorsal fin. At the larval stage, this group is characterized by the presence of pigmentation at the base of the second dorsal and anal fins, pigment along the dorsal and ventral margins of the caudal peduncle, and the presence of moderate to small head spines. Whether any of these characteristics defines a coherent phylogenetic group is an open question. SWFSC scientists are able to identify larvae of approximately 8-20 mm total length as belonging to this group of five species, but further identification to the species level is difficult.

The problem was approached by sequencing a 716 base pair (bp) portion of the cytochrome *b* gene of 23 adults representing these five species. SWFSC scientists have found apparently fixed differences in cytochrome *b* sequences that allow specimens of *S. entomelas*, *S. flavidus*, *S. melanops*, *S. mystinus*, and *S. serranoides* to be distinguished from one another (Table 3). Although morphological characteristics may vary with stage of development and environmental conditions, DNA sequences do not. Therefore, polymerase chain reaction (PCR) amplification and direct sequencing of the cytochrome *b* gene sequence permits identification of the larvae of these five species.

Table 3. Sequence differences found in a 716 bp portion of cytochrome *b*. At most positions from 0 to 716, the base composition was the same for all 5 species. At positions 183, 276, 278, 402, and 492 along the 716 bp fragment, base substitutions (mutations) were found that allowed unambiguous separation the DNA of the 5 target species. A = adenine, G = guanine, C = cytosine, T = thymine.

Species	183	276	278	402	492
S. entomelas (N=4)	G	A	G	C	T
S. flavidus (N=5)	G	G	G	T	T
S. melanops (N=6)	G	G	G	T	C
S. mystinus (N=3)	G	A	T	C	T
S. serranoides (N=5)	A	G	G	T	T

DNA sequencing is very useful for confirming or refuting the validity of various morphological differences as a basis for larval species identification, but even the automated techniques used here were too time consuming to be easily applied to routine identification problems involving large numbers of samples. Therefore, a simpler approach was needed. This simplified approach relied on the fact

that only a handful of the 716 bp sequenced was different between the species (Table 3). If the 716 bp DNA could be cut into characteristic length pieces, based on the sites that were different, DNA length patterns that were diagnostic of each species could be created.

Restriction enzymes are commercially available bacterial enzymes that recognize and cut DNA in specific locations that contain specific base sequences. If a restriction enzyme cuts the base sequence where a species difference occurs (e.g., sites 183, 276, 402, or 492 in Table 3), it will cut in one species but not in another. This produces either one long piece of DNA or two smaller pieces depending on whether the DNA was cut (restricted). Based on the sequence data, SWFSC scientists were able to pick a minimum set of restriction enzymes that would give a unique restriction fragment length polymorphism (RFLP) pattern for larvae of each species (Fig. 3). Figure 3 shows the restriction sites identified by the name of the restriction enzyme (e.g., Dde 1), and the characteristic length fragments that are produced in that rockfish species. The result appears as a simple "bar code" consisting of 1 to 5 dark bands on a gel. The position of each band is determined by its length. Although this method is based on sequencing the adults of a species at least once to discover sites where restriction enzymes may cut, it is faster and cheaper than sequencing every individual and permits the identification of a larger number of larvae in a shorter time.

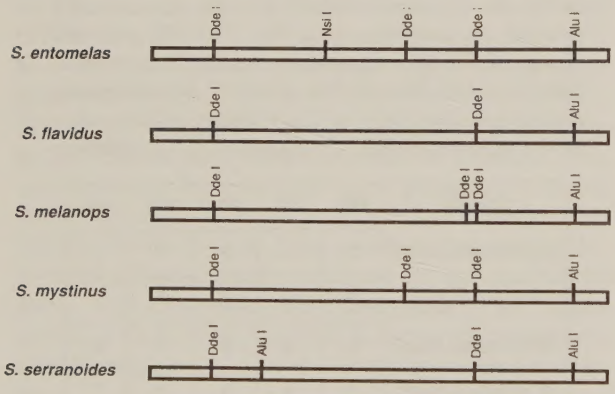

Figure 3. Species-specific restriction maps of a 716 bp portion of the cytochrome (*b*) gene. Three restriction enzymes (Dde 1, Nsi 1, Alu 1) were sufficient to cut equal length cytochrome (*b*) genes into unique combinations of different lengths based on species-specific differences in the primary DNA sequence. On a gel detection system (where small fragments migrate faster than larger fragments) a "bar code" characteristic of each species is produced.

The development of methods allowing the identification of relatively large numbers of individual rockfish larvae to species in net tow samples will allow identification of spawning times and locations for various rockfish species currently collected but unidentified in CalCOFI and other sampling programs. This in turn will allow better management of the various rockfish species. (B. Eitner, 619-546-7105; and R. D. Vetter, 619-546-7125)

MARINE MAMMAL DIVISION

La Jolla, California

Whale Habitat and Prey Survey of the Southern California Bight Completed

In August 1995, the Marine Mammal Division and the Antarctic Ecosystem Research Group (AERG) completed a Whale Habitat and Prey Survey off southern California. The primary objectives of the survey were to study the distribution and activities of blue and fin whales, survey the distribution of prey organisms, and map the distribution of physical and biological habitat variables that may influence the distribution of whales and their prey. The survey was designed to gain a more comprehensive assessment of the habitat than was possible on previous surveys designed specifically to make abundance estimates.

Blue whales were considered rare off California prior to being designated as protected in 1966 by the International Whaling Commission. Recently, increasing numbers of blue, fin, and humpback whales have been observed in the Channel Islands area. Data from a California Marine Mammal Survey in 1991 and a Population of *Delphinus* Stocks Survey in 1993 indicate that this area may contain the world's largest stock of blue whales (>2000). It is assumed that whales are feeding on aggregations of prey associated with fronts and enhanced productivity related to coastal upwelling. Wind-driven upwelling in this region peaks in May-June and declines gradually through November. The specific time frame for this survey was chosen because the whales seem to be more abundant in this area during August-September.

During the survey, 574 cetacean sightings were made, including 145 blue whale, 62 fin whale, and 80 humpback whale sightings. Each sighting consisted of 1 to 16 individuals (typically 2). Prey sam-

pling by AERG personnel consisted of 90 Isaacs-Kidd midwater trawl tows, 16 1-meter multiple opening/closing net and environmental sensing system tows, and continuous volume backscattering to 200 m at 38, 120, and 200 kHz. Habitat sampling also included 26 conductivity-temperature-depth (CTD) casts, with samples for chlorophyll, nutrients, and primary productivity, and 211 casts with a new mini-CTD/chlorophyll absorption meter system. To relate the observed whales to geographic and genetic stocks, photographs for identification of individual whales and projectile biopsies for genetic analyses were collected. Photographs were taken of 129 blue whales, 46 humpback whales, and 32 fin whales. Biopsies were obtained from 10 blue whales, 3 Pacific white-sided dolphins, and 8 bottlenose dolphins.

Preliminary analyses of samples and data indicate that blue whales were most abundant near some of the Channel Islands (Fig. 1). Satellite imagery showed that the whales were present only in colder, coastally upwelled water advected south of Point Conception. Feeding aggregations were associated with dense layers of *Thysanoessa spinifera*, the largest euphausiid in California waters. These layers were often found at 100-200 m depth, at the shelf break around the Channel Islands. Four samples of blue whale feces were collected. They are brick red due to euphausiid pigments and appear to contain *T. spinifera* parts.

Blue whale feeding aggregations are dynamic. Blue whales are abundant off southern California during summer and early fall, but they aggregate,

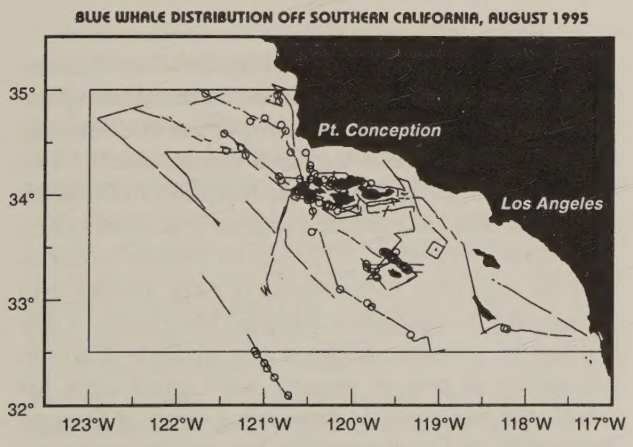

Figure 1. Blue whale sightings and on-effort tracklines during the 1995 Whale Habitat and Prey Survey.

move, and disperse from day to day. Preliminary results suggest that the dynamics of prey aggregations may be a very important factor affecting whale distribution and activity.

Further analysis of this year's results should help SWFSC researchers learn why the Channel Islands are a hot spot for whales and how blue, fin, and humpback whales share the prey resources found there. Future observations will help to assess how whale feeding grounds off California change over time. (P. Fiedler, 619-546-7016)

Tuna-Dolphin Separation/Attraction Workshop Held

On September 20, 1995, the Dolphin-Safe Research Program held a workshop in La Jolla, California, to evaluate the practicality of further research into separation and attraction methods for eliminating encirclement of dolphins during purse-seine sets on tuna-dolphin aggregations in the eastern tropical Pacific (ETP). Most large yellowfin tuna caught by purse seiners in the ETP are captured by setting nets around tuna-dolphin aggregations, a practice that leads to mortality of some dolphins. The current goal of U.S. legislation is to reduce the mortality of dolphins involved in the fishery to rates approaching zero. An obvious way to reduce mortality would be to separate the tunas and dolphins prior to encirclement by the purse-seine net. Numerous methods have been suggested to accomplish such separation, but preliminary tests have been unpromising in all cases.

The objective of the workshop was to discuss and evaluate past separation/attraction efforts and promising future efforts. Workshop participants included experts in dolphin behavior and auditory physiology, tuna behavior and physiology, tuna-dolphin fishing practices, and overall ecology of the tuna-dolphin association. From these discussions, the Dolphin-Safe Research Program will produce a "Handbook of Considerations and Recommendations" for future research to develop practical separation/attraction methods for eliminating dolphins from purse-seine sets on tuna-dolphin aggregations in the ETP. The handbook will strongly emphasize practical approaches and will include background information regarding the characteristics of dolphin-fishing, with details on animal behavior and physiology, school sizes and behavior, weather (e.g., wave heights, glare), and gear and equipment design (e.g., speed boat numbers and sizes, net skiff procedures and characteristics, length of time to set

net, net size, vessel size, helicopter characteristics). In particular, the handbook will emphasize the characteristics of the tuna-dolphin association, fishing practices, and fishing environment that are peculiar to this system and which should be considered in any practical solution.

The goal of the workshop was to produce a volume of practical background information that must be specifically considered and addressed in any future proposals for separation/attraction research. Providing interested researchers with this preliminary information should improve both the quantity and quality of practical separation/attraction proposals. (E. Edwards, 619-546-7099)

PACIFIC FISHERIES ENVIRONMENTAL GROUP

Monterey, California

PFEG and REINAS Cooperate in Ocean Monitoring on the Central California Coast

To gain better understanding of coastal ecosystem dynamics and variability, PFEG and the University of California, Santa Cruz (UCSC) are cooperating in an environmental monitoring project on the central California coast. UCSC's Realtime Environmental Integrated Network Analysis System (REINAS) collects information from shore stations around Monterey Bay, from moorings offshore, and from local research ships. This information can then be viewed graphically in near real-time using software developed by the REINAS program.

This spring REINAS engineers worked with NOAA Corps LT Heather Parker and Oceanographer Jerry Norton of PFEG to install a conductivity-temperature-depth measuring probe (CTD) at the California Department of Fish and Game laboratory at Granite Canyon, located 12 km north of Point Sur. Information from the CTD at 3.5 meters depth and a suite of meteorological instruments located on a coastal bluff above the CTD installation is transmitted to Point Sur and from there to the UCSC campus for archiving. CTD and all other REINAS information are available via the Internet at "http://csl.cse.ucsc.edu/reinas.html."

Coastal upwelling is one of the dominant processes controlling circulation along the shoreward margin of the California Current System. Upwelling plays a significant role in determining ecosystem energetics, because this process introduces high concentrations of nutrients into the upper layer of the ocean. Coastal flow patterns that control the dispersal and distribution of marine organisms are also closely linked to upwelling processes. The data from the CTD at Granite Canyon will allow researchers to understand the dynamics and variability of coastal ecosystems, which include many species of commercially important fish. An example of the high resolution data from the Granite Canyon CTD is shown in Figure 1.

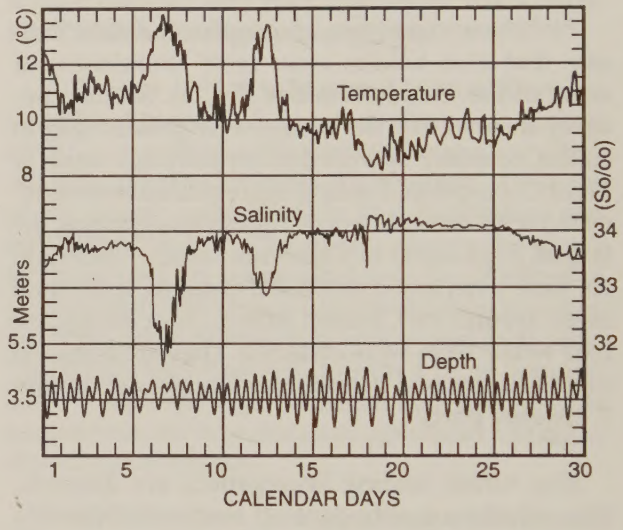

Figure 1. Temperature, salinity, and depth of CTD for April 1995 at Granite Canyon.

The REINAS engineers, led by Dr. Dan Fernandez, are of invaluable assistance in monitoring the project because they provide expertise in electronic data collection, archiving, and transmission. The CTD probe is an important contribution to REINAS because it adds an oceanic dimension to their extensive data network. PFEG contributes oceanographic expertise in monitoring data quality and developing a complete, calibrated time series. Calibration is possible because the Granite Canyon laboratory is one of several west coast sites for which the Marine Life Research Group at Scripps Institution of Oceanography has an ongoing program for daily sea surface temperature and salinity observation. The daily observations allow the CTD data stream to be checked against independent

measurements, and the 30 CTD scans per hour give information about the degree to which higher frequency (>1 cycle/day) events such as tides bias the daily observations. (J. Norton, 408-648-9031)

Rotational Assignment

The Pacific Fisheries Environmental Group (PFEG) recently provided a rotational assignment opportunity to Stephania Bolden, a research fishery biologist at the NMFS Southeast Fisheries Science Center (SEFSC). While on assignment at PFEG from April through July 1995, Bolden gathered and analyzed historical information on regional fisheries, which will support the objectives of ongoing research projects at PFEG, including: analysis of multi-decadal trends in species composition and size of fishes taken in Monterey Bay recreational fisheries, evaluation of deepwater habitats as small-scale harvest refugia for rockfishes, and evaluating the role of marine harvest reserves in fishery management and conservation of biodiversity. Bolden's work in the SEFSC Reef Resources Program was valuable in applying lessons learned from tropical examples of harvest refugia to a temperate water system.

The groundfish assemblages on the continental shelf of central California are tremendously diverse and have been the target of both recreational and commercial fisheries using various types of gear since the early 1900s. Historically, rockfish landings in particular have been especially high in the Monterey Bay area, although there are now indications that numbers and sizes are decreasing for some species. Both federal and state monitoring programs have collected critical information over several years on species, size, and relative abundance of these assemblages.

As the effects of fisheries on coastal resources are considered, these disparate sources of data become critical in evaluating change in coastal rockfish populations. The research activities assumed by Bolden during her tenure at PFEG included: inventory of potential data sources; evaluation of data sets in terms of variables measured, accessibility, biases, and temporal/spatial range; development of an approach to analyze changes in fishery resources based on these disparate data sets; studies on fisheries recruitment in the California Current; and assembling ecological, conservation, political, and socio-economic literature on the establishment of marine harvest reserves as an alternate approach to fisheries management. Bolden and Mary Yoklavich, research fishery biologist at PFEG, currently are developing a short paper on the application of harvest refugia concepts to coastal rockfish resources off central California. (M. Yoklavich, 408-648-9036)

PELAGIC FISHERIES RESOURCES DIVISION

La Jolla, California

MULTISPECIES DATA COLLECTION AND EVALUATION PROGRAM

Western Pacific Yellowfin Research Group Meeting

Fishery Biologists Gary Sakagawa and Pierre Kleiber and Mathematical Statistician Atilio Coan attended the fifth meeting of the Western Pacific Yellowfin Research Group (WPYRG) in Noumea, New Caledonia, August 21-23, 1995. They each presented a paper and led sessions at the meeting. The three papers are summarized here.

(1) "U.S. fisheries catching tropical tunas in the central-western Pacific Ocean, 1993-1994," by A. Coan and D. Prescott (computer specialist, SWFSC). Total yellowfin, bigeye, and skipjack tuna catches, sizes of fish caught, and daily fishing activities for U.S. fisheries operating in the central and western Pacific were presented. Total catch for these fisheries was more than 210,000 t in 1994, with skipjack tuna accounting for more than 70% of the catch and yellowfin tuna 25%.

(2) "Bigeye tuna catch in the U.S. tuna purse seine fishery of the central-western Pacific," by A. Coan, G. Sakagawa, and D. Prescott. Results of a study to determine the amount of bigeye tuna that has historically been reported as yellowfin tuna landings from U.S. purse seiners fishing in the central and western Pacific were presented. A high proportion of bigeye tunas is found in landings from sets associated with floating objects, especially when these sets involved fish of less than 9 kg. Lower proportions of the catch were bigeye tuna in sets on free-swimming schools.

(3) "Does schooling behavior affect estimates of movement parameters from tagging data?" by P. Kleiber. A model was used to assess effects of schooling behavior on spatial-temporal patterns of tag returns from tagging experiments. Estimates of fishing mortality, natural mortality, advection, and

diffusion are less precise and the goodness of model fit is poorer when fish school than when they do not school.

The WPYRG agenda included a review of fisheries, updating of databases for the period 1970 to 1994, and consideration of advances in biological and stock assessment research. Central and western Pacific catches in 1994 reached more than 370,000 t of yellowfin tuna, 65,900 t of bigeye tuna, and 1,024,400 t of skipjack tuna. Advances in biological and stock assessment research were primarily in the development of a yellowfin tuna stock assessment model and reproductive biology of yellowfin tuna. (A. Coan, 619-546-7079)

Quick Reaction Grant

In January 1995, the SWFSC received an invitation from NMFS headquarters to submit proposals for funding under the Quick Reaction Grant Program. These funds were made available through the NMFS Human Resources Development Plan to implement unfunded training projects for employee enhancement and development. The criteria for proposal funding were innovation, transferability, human resource improvement, and effect on diversity and skills.

Biological Technician Rand Rasmussen took the lead in developing a proposal for the Center. The objectives of the proposal were (1) to provide support for junior scientists (grade GS-09 and lower) to attend scientific conferences to develop professional interactions and improve their skills and abilities and (2) to increase employee performance and retention. Justification for this funding was based on the current budget limitations, which restrict attendance at professional conferences to senior-level scientists and may disproportionally affect women, minorities, and handicapped individuals who are not fully represented in senior-level positions.

Rasmussen's proposal, the "Junior Scientist Development and Assistance Project," was awarded the maximum amount of funding obtainable—$5,000. The availability of these funds was announced throughout the Center's divisions and laboratories. Applications for grant support were received through each junior scientist's supervisor. Priority was given to those whose careers would be enhanced by attending a conference and secondarily to those who were women, minorities, or handicapped.

Eight junior scientists were selected to receive support to attend a scientific conference. Three of these were minorities, four were women, two were junior authors of papers to be presented, and two were senior authors. Support was distributed throughout the Center, including the Honolulu and Tiburon Laboratories and three divisions in the La Jolla Laboratory. Junior scientists attended five different professional conferences in the United States and England. (R. Rasmussen, 619-546-7184)

TUNA BILLFISH ASSESSMENT PROGRAM

Abundance Indexing for Pelagic Sharks in the Southern California Bight

Pelagic shark landings in California peaked in 1982 as the driftnet fishery for swordfish and thresher sharks expanded. Shark landings have subsequently declined. The catch of shortfin mako sharks fell from a high of 900 mt in 1982 to only 100 mt in 1985. Catches increased in 1986 and 1987 as a new commercial longline fishery developed for shortfin mako and blue sharks. This longline fishery operated as an experimental fishery between 1988 and 1991. It was discontinued after the 1991 season because a high percentage of juvenile sharks were caught and bycatch of blue sharks was excessive. Although some attempts were made to market blue sharks, the fishery was unable to establish a successful market. Blue sharks continued to be discarded at sea and the magnitude of that bycatch has never been fully known.

Attempts to standardize catch-per-unit-effort (CPUE) and to determine abundance for shortfin mako and blue sharks in the driftnet fishery have been hampered by changing goals within the fishery and increasing regulations governing the fishery. This resulted in a ever-changing distribution of catch and effort over time. It was determined that an abundance index might be constructed to provide estimates of relative abundance based on the four-year commercial longline fishery.

The Pelagic Fisheries Research Division (PFRD) began an experiment in 1993 to develop an index of abundance for these sharks in the Southern California Bight. This index is based on logbook and landings data reported from the commercial longline fishery during 1988 to 1991.

Experimental procedures and fishing operations were worked out during the 1993 cruise on the NOAA research vessel *David Starr Jordan*. To limit

sampling bias and changes in gear selectivity, the fishing gear used to sample shark abundance was identical to that used by the commercial longline fleet. The primary difference in our sampling design was that sampling sets were shorter in time.

The California Department of Fish and Game (CDFG) joined the effort in 1993 with a cruise to tag and release pelagic sharks. Although both cruises yielded much information, the 1993 data were not suitable for indexing shark populations due to modifications in the fishing operations while developing standard fishing techniques.

The actual experiment began in July 1994 with a 5-day tagging cruise aboard the CDFG research vessel *Mako*. PFRD's 14-day cruise on the *David Starr Jordan* followed, and the season's sampling ended with a 12-day cruise on the *Mako* in the fall. In all of 1994, 47 sets were made during 31 days of sampling. A total of 215 shortfin mako sharks, 432 blue sharks, and 1 thresher shark were caught, and 114 pelagic rays also were taken. The overall catch rate for 1994 was 10.6 sharks per 100 hooks set. The highest catch rates occurred in July for mako sharks (3.4 per 100 hooks) and in October for blue sharks (14.2 per 100 hooks). Sampling locations were selected from productive fishing areas known from skipper logbooks. Although CPUE varied by cruise, time, and area, the areas southeast of Santa Catalina Island and east of San Clemente Island were the most productive.

The 1995 sampling season began in June with a 10-day cruise on the *Mako*. To produce a repeatable index of shark abundance in the Southern California Bight, a stratified sampling scheme was employed with a predetermined set of sampling stations for the PFRD cruise on board the CDFG research vessel *Yellowfin*. These stations were determined from catch and effort data reported in logbooks during the four-year commercial longline fishery. Catch and effort data reported in CDFG logbooks were examined to provide average catch, distribution, and variance in CPUE by CDFG block number. Several CDFG blocks yielded consistently high catches and could be sampled repeatedly to provide a reasonable sampling scheme.

In 1995, a total of 42 sampling sets were made during 30 days at sea. A total of 188 mako, 298 blue, and 9 thresher sharks were captured, and 46 pelagic rays also were caught. The overall catch rate for 1995 was 6.8 sharks per 100 hooks. The highest catches occurred in late July, 10 to 20 miles southeast of Santa Catalina Island. The highest catch rate for mako sharks was 2.9 per 100 hooks and the highest catch rate for blue sharks was 4.7 per 100 hooks. Again, catch rates varied by cruise, time, and area.

The average catch rate of shortfin mako sharks in the commercial fishery was 6.1 per 100 hooks set over the 4-year period. Sampling catch rates of 4.1 in 1994 and 2.9 in 1995 do not necessarily indicate a decline in relative abundance. The sampling design calls for a shorter soak time for the gear, which may result in a lower CPUE. The need for more survey work and monitoring of the driftnet fishery is apparent. (D. Holts, 619-546-7186)

PELAGIC ECOSYSTEM MODELING

Effect of Schooling Behavior on Analyses of Tagging Data

Tagging data can provide powerful information to estimate movement parameters and other parameters of population dynamics. The numerical methods used in such estimation almost always make the assumption that tagged fish are independent of each other. However, for schooling fish such as tuna, independence of movement is clearly not the case. Kleiber and Hampton (1994; see Publications section of this report) speculate that estimates of movement parameters might be indifferent to schooling behavior even though such behavior is not incorporated in the estimation model. Their speculation is based on the expectation that movement parameters for individual fish would be the same as for schools (except at the resolution of movement within schools). Otherwise schools would have to be some sort of wave phenomenon.

To check that speculation, Fishery Biologist Pierre Kleiber conducted a modeling experiment in which synthetic tagging data were created with and without schooling behavior and with known parameter values of advection, diffusion, natural mortality, and fishing mortality. An estimation model without schooling was used to estimate the original model parameter values from both the schooling and non-schooling tagging data. A non-linear model fitting technique was used to find the parameter values that minimize an objective function for which smaller values indicate better fit to the data.

Parameter values were estimated from 200 sets of synthetic data from non-schooling fish and 200 sets from schooling fish. The minimum objective function values tend to be about the same for

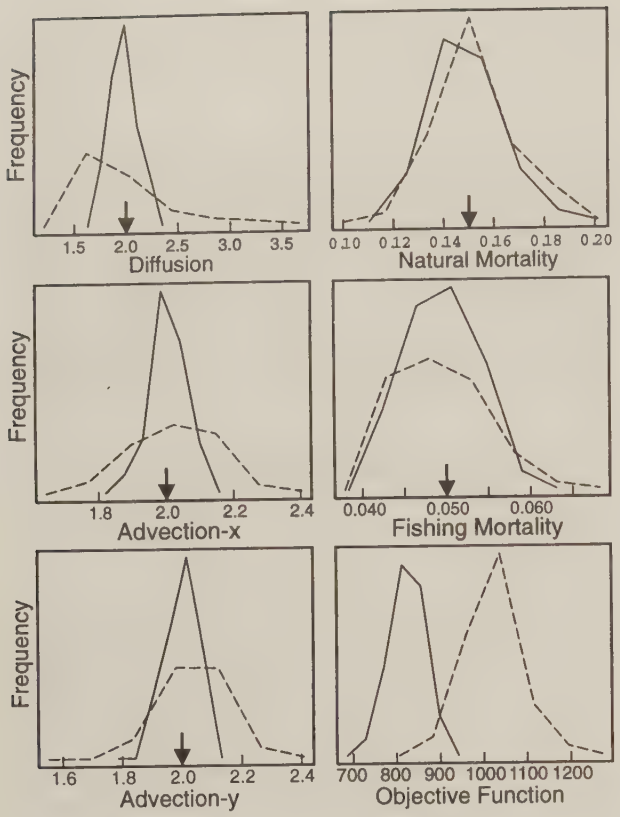

Figure 1. Distributions of parameter estimates and minimum objective function values from 200 non-schooling data sets (solid lines) and 200 schooling data sets (dashed lines). Arrows indicate the "real" parameter values, that is, the values used to produce the synthetic data.

schooling and non-schooling fish (Fig. 1). Therefore, the estimation model does not fit the schooling data as well as it does the non-schooling data. Nevertheless, comparison of the parameter estimates with the parameter values used to produce the synthetic data shows little indication of bias in any of the parameters in analyzing either the schooling or non-schooling data sets (Fig. 1). However, for the movement parameters (advection and diffusion), the estimates for schooling fish are less precise than for non-schooling fish.

At least for the simple movement model used here, the expectation of unbiased parameter estimates is confirmed even when tag data from schooling fish are analyzed with a non-schooling model. It remains to test other, more complicated movement models such as that developed by Kleiber and Hampton (1994). (P. Kleiber, 619-546-7076)

TIBURON LABORATORY

Tiburon, California

GROUNDFISH COMMUNITIES INVESTIGATION

Occurrence of Coho Salmon in Coastal Streams to be Studied

The Tiburon Laboratory has begun a program to investigate the abundance and distribution of coho salmon (*Oncorhynchus kisutch*) in coastal streams over time. This effort is in response to a petition now under review by NMFS that would list this salmonid as a threatened species. Native coho salmon in California have declined substantially during the past 50 years, with estimates suggesting a decrease from 1 million spawning fish in the 1940s to 5,000 fish at present. This decline has been especially great in the southern part of the species' range. The State of California already recognizes the coho as threatened south of San Francisco and has moved to list it as endangered. Both federal and state agencies acknowledge that their listings are based on limited data, however, and recognize the great need for additional information on the species.

Present data on occurrences of coho salmon in coastal streams are fragmented and not directly comparable. Although a vast amount of information has been collected, there has been little coordination of the efforts involved and virtually no standardization of methods. For example, there has been no attempt to determine correspondence between the three major ways that numbers have been produced: electrofishing, underwater visual counts of juveniles, and carcass counts of spawning adults.

The goals of the new program are (1) to determine how current coho salmon distribution compares with historical distributions, (2) to develop measures of correspondence between the methods used to measure population trends, (3) to initiate a time series of data on coho salmon occurrences in a range of representative coastal streams and rivers, and (4) to develop a better understanding of the physical habitat and biological community of coho salmon in central California.

A first step toward accomplishing these goals is to convene a workshop on sampling methodology for coastal salmonids. The workshop will survey current central California research efforts in terms

of goals, methodology, and geographical scope. An important part of the workshop will be to record the individual researchers' impressions of successes and failures of their methodologies. The participants will help to analyze the strengths and weakness of current methodologies and establish a standard protocol for each of them. (P. Adams, 415-435-3149)

GROUNDFISH ANALYSIS INVESTIGATION

Tiburon Laboratory Develops ORACLE Database

Fishery Biologist Donald Pearson has created an ORACLE database known as TIGRbase (TIburon GRoundfish database). TIGRbase contains the following data: west coast commercial market samples for lingcod, sablefish, and rockfish; research samples for adult shortbelly and juvenile rockfish; recreational fishery samples for lingcod and rockfish; California commercial rockfish landings; expanded age and length composition data for California's commercial rockfish fishery; California trawl log data; California commercial landing receipt data; National Ocean Service (NOS) buoy data; MOODS (Master Oceanographic Observation Data Set); sea level and upwelling indices; southern oscillation indices; Aleutian Low indices; NOS shore station observational data; and CTD sample data collected during cruises. Two special tables allow ready conversion between different types of species coding conventions and area coding formats to facilitate creating relationships.

TIGRbase can be accessed using Tiburon's ORACLE Data Browser, SQL+, or SAS Access. It will eventually include data from the Tiburon Laboratory's salmon research program, a planned ocean dredge spoil monitoring program, and trawl logs from Oregon and Washington. TIGRbase is currently linked to other fisheries databases (PacFIN, RACEbase, NORPac, CalCOFI). (D. Pearson, 415-435-3149, ext. 237)

GROUNDFISH PHYSIOLOGICAL ECOLOGY INVESTIGATION

Physiological Condition of Shortbelly Rockfish Young-of-the-year

In 1993, a study was initiated to determine variation of physiological condition in young-of-the-year (YOY) shortbelly rockfish, *Sebastes jordani*. By measuring the physiological condition of YOY from three submarine canyon areas off central California, researchers hoped to determine their potential to survive through the early life stages when food availability can vary significantly.

The main objectives were to determine if physiological condition of shortbelly rockfish varies on temporal and spatial bases and the effects of seasonal and annual environmental conditions. YOY shortbelly rockfish and environmental data were collected during February through June on board the NOAA research vessel *David Starr Jordan*. Each of the three submarine canyon areas (Bodega, Pioneer, and Ascension Canyons) was divided into three longitudinal sections covering the canyon axis. Sections were determined by the distance from shore with the midshore section representing the central spawning area around the 100-fathom line. Nearshore locations were 5-10 miles, midshore 10-20 miles, and offshore >20 miles from the coast.

Several measures were used to assess the physiological condition of larvae, focusing on total lipid and lipid class composition. For lipid determinations, larvae were pooled to reach a biomass necessary for analysis. Composites of preflexion larvae ranged from 25 to 35 individuals and for postflexion larvae, 5 to 10 individuals were pooled. Standard length, oil globule diameter (in preflexion stages), and feeding rank (values range 0-5; empty to full capacity) were also measured on individual larvae. Lipid analyses involved quantification and fractionation of total lipid to determine concentrations and ratios of neutral lipids [generally regarded as energy-yielding (E) triacylglycerols (TAG) and esters] and polar lipids [considered as primarily structural (S) phospholipids and cholesterol]. The concentrations of energy-yielding lipids and the ratio of neutral to polar lipids (E/S) indicate energetic or physiological status. Another ratio, triacylglycerol (the main source of fuel) to cholesterol (cell membrane constituent) (TAG/CHOL), reflects nutritional status on a short-term basis because TAG is readily utilized whereas cholesterol levels remain relatively stable. The best estimate of condition results from a synthesis of data from a combination of lipid measures, along with other physiological variables. For example, larvae with higher levels of all lipid classes and total lipid have a better chance of survival than ones with high E/S ratios but low lipid concentrations because all lipids, including phospholipids, can be metabolized during periods of low food abundance.

Initial data analyses of condition factors among nearshore, midshore, and offshore locations for postflexion stages in 1993 indicated larvae from

offshore appeared to be in a better nutritional state than larvae in nearshore or midshore locations (Table 1). Larvae offshore were significantly larger and had greater TAG, E/S, TAG/CHOL, and higher incidences of feeding. Better nutritional status offshore may be explained by favorable feeding conditions although observed feeding ranks reflected only recent conditions.

Differences in larval condition among nearshore, midshore, and offshore sections in 1994 were not as evident as in 1993 (Table 1). In 1994, postflexion larvae were similar in size, but had significantly greater TAG and TAG/CHOL in the midshore locations. It seems that larvae in the midshore section had more energetic lipids readily available than larvae in nearshore and offshore sites.

An interannual comparison between 1993 and 1994 postflexion larvae from the Bodega Canyon area showed 1994 larvae were in better nutritional condition (Table 2). In 1994, larvae contained significantly more total lipid, TAG, nonesterified fatty acids (NEFA), cholesterol, and polar lipids than in

Table 2. Mean and standard error (in parentheses) for condition factors of postflexion shortbelly rockfish collected in 1993 and 1994 from the Bodega Canyon area. Lipid values are concentrations in mg/g. The number of composites is indicated by *n*.

FACTOR	1993	1994
n	17	27
LENGTH (mm)	8.71 (0.36)	9.14 (0.22)
FEEDING (rank)	2.55 (0.26)	2.54 (0.17)
TOT LIPID	18.69 (0.55)	22.07(0.46) *
ESTER	0.38 (0.09)	0.30 (0.06)
TAG	1.46 (0.18)	2.36 (0.16) *
NEFA	0.45 (0.06)	0.65 (0.06) *
CHOL	2.77 (0.14)	4.01 (0.11) *
PHOSPHOLIPIDS	13.60 (0.61)	14.74 (0.44)†
E/S	0.12 (0.01)	0.15 (0.01)
TAG/CHOL	0.55 (0.07)	0.59 (0.04)

* ($P<0.05$) 1994 significantly > than 1993.
† ($P<0.10$) 1994 significantly > than 1993.

Table 1. Mean and standard error (in parentheses) for condition factors of postflexion shortbelly rockfish. Comparisons were made among means by distance from shore for 1993 and 1994 larvae collected in the Bodega Canyon area. Lipid values are concentrations in mg/g. The number of composites is indicated by *n*.

	1993			1994		
FACTOR	NEAR	MID	OFF	NEAR	MID	OFF
n	2	7	8	8	10	9
LENGTH (mm)	8.33	7.89 (0.26)	9.00 * (1.98)	8.98 (0.38)	9.67 (0.34)	8.69 (0.36)
FEED (rank)	2.24	1.83 (0.17)	3.20 * (0.19)	2.33 (0.30)	2.21 (0.27)	3.10 § (0.28)
TOT LIPID	16.84	19.93 (0.80)	18.09 (0.75)	22.25 (0.84)	22.94 (0.75)	20.94 (0.79)
ESTER	0.27	0.42 (0.16)	0.32 (0.32)	0.22 (0.11)	0.23 (0.10)	0.44 (0.10)
TAG	0.71	0.98 (0.17)	2.09 * (0.15)	2.17 (0.25)	2.97 ‡ (0.23)	1.86 (0.24)
NEFA	0.42	0.63 (0.06)	0.33 (0.05)	0.53 (0.10)	0.56 (0.09)	0.86* (0.10)
CHOL	3.21	2.54 (0.20)	2.54 (0.17)	4.08 (0.21)	4.06 (0.19)	3.90 (0.20)
PHOS	12.24	15.51 † (0.77)	12.82 (0.67)	15.25 (0.82)	15.12 (0.73)	13.89 (0.77)
E/S	0.07	0.08 (0.02)	0.16 * (0.01)	0.12 (0.02)	0.17 (0.02)	0.14 (0.02)
TAG/CHOL	0.23	0.38 (0.09)	0.75 * (0.30)	0.53 (0.10)	0.74 ‡ (0.26)	0.48 (0.08)

($P<0.05$)
* significantly > than near and midshore
† significantly > than inshore
‡ significantly > than off and nearshore
§ significantly > than midshore

Table 3. ANOVA summary of location and stage of embryonic development (EMS) on embryonic lipid and protein concentrations. $N = 182$. Fish were obtained from three locations (Ascension, Pioneer, and Bodega submarine canyons) and embryos were categorized according to maturation stage (EMS 1, late vitellogenesis; EMS 2 through 33, 2-celled stage to hatched larva).

	Model			Effects ($P > F$)		
Variable	F	P	r^2	Location	EMS	Location x EMS
Total Protein	26.14	0.0001	0.9194	0.01	0.0001	0.05
Total Lipid	26.97	0.0001	0.9136	0.0001	0.0001	0.01
Esters	9.36	0.0001	0.7859	0.05	0.0001	NS
Triacylglycerols	20.89	0.0001	0.8912	0.001	0.0001	0.05
Nonesterified Fatty Acids	0.41	0.9998	0.1379	NS	NS	NS
Cholesterol	17.87	0.0001	0.8751	0.0001	0.0001	0.05
Phospholipids	30.28	0.0001	0.9224	0.0001	0.0001	0.01

1993 for similar sized larvae. The combination of both higher total lipid and individual component levels provides a long-term measure of better condition, whereby more lipids are available to survive periods of low food abundance. These results seem to relate to YOY recruitment abundance data collected by the Groundfish Analysis Investigation. They found greater numbers of juveniles in the Bodega Canyon area in 1994 (May/June juvenile surveys) compared to 1993. Possibly, better nutritional condition during pelagic larval stages contributed to greater juvenile survival in 1994 in the Bodega Canyon area.

Further data analyses, including more developmental stages, southern canyon areas (Pioneer and Ascension), and years, may reveal additional patterns of variation in physiological condition. Ultimately, the effects of environmental variation will be related to physiological condition on seasonal and annual bases to achieve a better understanding of fluctuations in year-class strength. (E. Norton, 415-435-3149, ext. 245)

Relationship Between Nutritional Status of Shortbelly Rockfish Embryos at Parturition and Pelagic Larvae

Researchers with yellowtail rockfish, *Sebastes flavidus*, showed that the dynamics of lipid and protein metabolism in ovaries during embryogenesis varied from year to year and related to differences in maternal and environmental factors. For example, during five annual reproductive cycles, 1988-1992, ovarian lipid concentration was significantly correlated to relative fecundity (number of eggs/weight somatic tissue; $r^2 = 0.826$, $P < 0.05$) and estimates of upwelling intensity ($r^2 = 0.748$, $P < 0.05$). These results supported the hypothesis that nutritional status during embryonic develpment is a function of environmental conditions and influences reproductive output of rockfish along the California coast. Tiburon Laboratory researchers have extended their study of this linkage to another rockfish species, the shortbelly rockfish, *Sebastes jordani*. The ability to identify and collect large numbers of pelagic larvae provided the unique opportunity to evaluate the contribution of ovarian nutritional dynamics to growth, condition, and survival of early pelagic larvae at a time when mortality is highest.

In 1994, changes in ovary lipid and protein content during embryogenesis were measured in three populations of shortbelly rockfish to determine whether the nutritional status of larvae at parturition varied by population. Gravid shortbelly rockfish were collected from populations at three submarine canyons—Ascension, Pioneer, and Bodega. Ovaries were excised from females in stages of development ranging from late vitellogenesis through fully formed, hatched larvae. Tissue samples were analyzed for protein and lipid content. The concentrations of total protein, total lipid, and lipid classes [wax/sterol esters, triacylglycerols (TAG), nonesterified fatty acids (NEFA), cholesterol (CHOL), and polar (or phospho-) lipids (PL)] in ovaries were analyzed to determine the effects of capture location and embryo maturation stage (EMS).

Two-way analysis of variance (ANOVA) found that EMS and canyon location of the population were highly significant in contributing to the variation of lipid and protein variables (Table 3). Although maturation stage accounted for the greatest variability in lipids and protein, location was also a significant main effect, particularly for lipid variables. The interaction of location and EMS was statistically significant for total protein, total lipid, TAG, CHOL, and PL, suggesting that changes in concentrations of these variables during embryo development varied significantly among the populations.

Protein and lipids declined from late vitellogenesis (EMS 1) through embryo maturation to hatched larvae (EMS 33). This pattern is typical of lecithotrophic livebearers. The decrease in total protein and lipid was much greater than that found in yellowtail rockfish embryos which are supplemented matrotrophically during gestation.

The general pattern of protein and lipid declines during embryonic development was evident in each canyon's population. Linear regressions of lipid and protein variables by EMS for each canyon's population were all highly significant ($P < 0.0001$) and produced estimated slopes and intercepts significantly different from zero ($P < 0.0001$). Consistent with the results of the ANOVA, slopes and intercepts of variables among the populations varied. Using these regression equations, it was possible to estimate the nutritional composition of larvae at parturition for each population and thus compare the nutritional status of larvae as they enter the environment.

In 1994, the larvae originating from Ascension Canyon appeared to have the greatest content of protein and lipids of all classes (Table 4) and, therefore, the highest potential for survival and growth during the first days in the environment when endogenous reserves sustain them until adequate food becomes available. The year-class born at Bodega Canyon, though not as rich in reserves as those from Ascension, would seem to be better prepared to grow and survive than the larvae from the Pioneer Canyon population. This was particularly apparent from the TAG concentrations. Triacylglycerols are the primary energy source for metabolism.

Table 4. Estimates of lipid and protein concentrations of larvae at parturition from populations at three submarine canyons off the central California coast. Values are for final embryo maturation stage, hatched larvae (EMS 33), from linear regressions of variable by embryo maturation stage for populations from each canyon. All estimates are mg/g fresh weight.

Variable	Ascension Canyon	Pioneer Canyon	Bodega Canyon
Total Protein	90.0	62.8	63.1
Total Lipid	40.5	19.9	29.8
Esters	2.8	1.1	1.9
Triacylglycerols	18.2	5.8	11.0
Cholesterol	2.3	1.6	2.2
Phospholipids	17.3	10.9	14.6

Differences in the nutritional status of newborn larvae from the populations at the three canyons were not apparent in pelagic larvae collected by bongo nets (Fig. 1). The results of lipid analyses on preflexion and postflexion larvae indicated that any nutritional advantage conferred on newborn larvae was lost during the first few days to weeks in the environment. The concentrations of total lipid, TAG, PL, and other lipid classes in preflexion larvae from Ascension and Pioneer Canyons were essentially identical. Preflexion larvae from Bodega Canyon could not be assessed since none were found in any net tows. The preflexion stage has been estimated to last approximately 15 days in this species; thus, nutritional differences at birth are lost in surviving larvae soon after parturition. Of course, additional nutritional reserves may translate into greater survival of the year-class from Ascension Canyon. Unfortunately, data on larval abundance for the three canyons are unavailable. The possibility also exists that larvae released from all three populations are mixed together by currents. Thus, those pelagic larvae found in each canyon area may originate from any or all reproducing populations and therefore could have similar nutritional profiles.

By the time larvae attained the postflexion stage, levels of lipids increased in populations from the

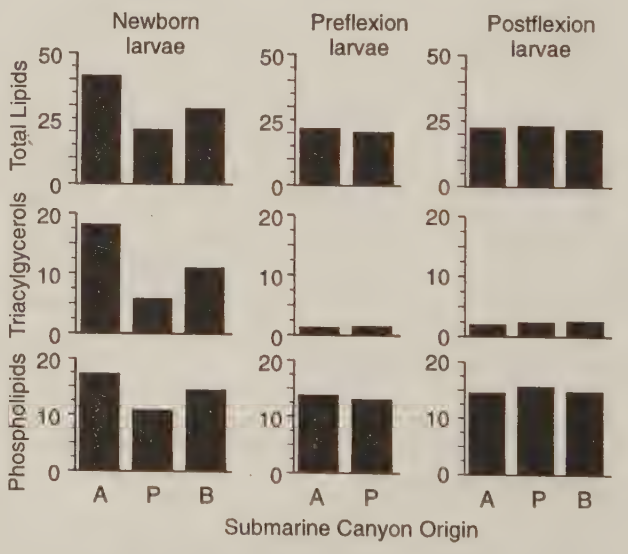

Figure 1. Estimated concentrations of total lipids, triacylglycerols and phospholipids in newborn larvae and mean concentrations in preflexion and postflexion pelagic larvae of shortbelly rockfish from Ascension (A), Pioneer (P), and Bodega (B) submarine canyons. Concentrations are mg/g fresh weight.

three canyons (Fig. 1). This indicated that feeding had become the primary source of nutrition and the anabolic-catabolic balance had shifted toward net energy accumulation. (R. B. MacFarlane and E. Norton, 415-435-3149)

INFORMATION TECHNOLOGY SERVICES

National Financial Reporting System

After 12 years of operation, the SWFSC's Financial Reporting System will be replaced in October 1995 by a national Financial Reporting System (FRS). The new system is based on a system used by the NMFS Northeast Fisheries Science Center and developed using the ORACLE Relational Database Management System.

The new FRS software and database will be installed on IT-95 host computers in several NMFS locations throughout the country. Using technology available through the IT-95 computers and wide area network, the databases at those locations will be linked in a distributed mode that will allow NMFS headquarters to query data and produce timely financial reports. In December, system upgrades will provide additional links to data sources such as time and attendance, personnel, labor, small purchasing system, and travel manager. The new FRS will be accessible to all SWFSC staff using appropriate hardware and user accounts. (R. Bistodeau, 619-546-7055)

PUBLICATIONS

Published

Adams, P. B., J. H. Butler, C. H. Baxter, T. E. Laidig, K. Dahlin, and W. W. Wakefield. 1995. Population estimates of Pacific coast groundfishes from video transects and swept-area trawls. Fish. Bull. 93:446-455.

Demersal fish surveys are used for two purposes: to detect trends in multispecies communities for environmental assessment and to provide fishery independent stock assessments for management. Remotely operated vehicle (ROV) and swept-area trawl surveys are compared to evaluate their strengths and weaknesses for these two purposes. ROV abundance estimates tended to be higher and have lower coefficients of variation than did trawl abundance estimates. This trend is greatest for benthic species and particularly so for small, cylindrically shaped fishes. For patchily distributed, off-bottom fishes such as rockfish, *Sebastes* spp., sablefish, *Anoplopoma fimbria*, and Pacific whiting, *Merluccius productus*, the results vary between ROV and trawl estimates. For environmental assessment, the ROV estimates are superior because, for most species, abundances are higher and smaller changes can be detected. For fisheries management of commercially important species, the results are divided. Dover sole, *Microstomus pacificus*, and thornyheads, *Sebastolobus* spp., have higher ROV abundance estimates and lower coefficients of variation than the trawl. Sablefish, which exhibit more off-bottom behavior, have higher trawl estimates at two of three depths. The ROV and trawl provide different types of information not available from other gear. Much of the difference between the two types of surveys stems from the nature of the sampling gear and from the behavior, body shape, and size of the fishes.

Benetti, D. D., R. W. Brill, and S. A. Kraul, Jr. 1995. The standard metabolic rate of dolphin fish. J. Fish. Biol. 46(6):987-996.

The standard metabolic rates (SMRs) of 11 (1.395-4.125 kg) dolphin fish (mahimahi or dorado, *Coryphaena hippurus*) were measured at 25° ± 0.5 °C. Fish were prevented from swimming with neuromuscular blocking agents and force ventilated. Heart rates were determined simultaneously. SMRs (358-726 mg 0_2h^{-1}) were several times those of other similarly sized active teleosts such as salmonids, but close to those of tunas. Heart rates (84-161 beats min^{-1}) were also high, but alike those of tunas under similar circumstances. As in tunas, the high SMR of dolphin fish may result from high osmoregulatory costs engendered by their large gill surface areas and/or other adaptations necessary for achieving exceptionally high maximum metabolic rates.

Demer, D. A., and R. P. Hewitt. 1995. Bias in acoustic biomass estimates of *Euphausia superba* due to diel vertical migration. Deep-Sea Res. I 42(4):455-475.

The diel vertical migration (DVM) of Antarctic krill, *Euphausia superba*, can greatly bias the results of qualitative hydroacoustic surveys which are conducted with a down-looking sonar and irrespective of the time of day. To demonstrate and quantify these negative biases on both the estimates of biomass distribution and abundance, a time-depth-density analysis was performed. Data were collected, as part of the U.S. Antarctic Marine Living Resources Program, in the vicinities of Elephant Island, Antarctica, during the austral summers of 1992 and 1993. Five surveys were conducted in 1992; two covered a 105 by 105 nmi area centered on Elephant Island, two encompassed a 60 by 35 nmi area immediately to the north of the island, and one covered a 1 nmi^2 area centered on a large krill

swarm to the west of Seal Island. The 1993 data include repetitions of the two small-area and two large-area surveys. Average krill volume densities were calculated for each hour as well as for three daily periods: day, twilight, and night. These data were normalized and presented as a probability of daily average density. With spectral analysis to identify the frequencies of migration, a four-term periodic function was fitted to the probability density function of average daily biomass versus local apparent time. This function was transformed to create a temporal compensation function (TCF) for upwardly adjusting acoustic biomass estimates. The TCF was then applied to the original 1992 survey data; the resulting biomass estimates are an average of 49.5% higher than those calculated disregarding biases due to DVM. The effect of DVM on the estimates of krill distribution is illustrated by a comparison of compensated and uncompensated density maps of two 1992 surveys. Through this technique, high-density krill areas are revealed where uncompensated maps indicated low densities.

———, and L. V. Martin. 1995. Zooplankton target strength: volumetric or areal dependence? J. Acoust. Soc. Am. 98(2):1111-1118.

Target strengths (TSs) of various zooplankton were measured at 200 kHz, 420 kHz, and 1 MHz, and the dependence of these data on animal volume versus cross-sectional area was explored. The 420-kHz and 1-MHz data were collected with a dual-beam sonar system and the 200-kHz data with a split-beam system. Experiments were conducted with live, tethered individuals in an enclosure filled with filtered sea water. The data were compared to both empirical and theoretical models of reduced target strength (TS normalized by the square of the animal length) versus *ka* (the product of wave number and equivalent cylindrical radius). The theoretical models chosen for this comparison were two versions of a high-pass bent-cylinder model (Stanton 1989b) that indicate TS is dependent on the cross-sectional area. The dependence of acoustic backscattering on animal volume or area was tested by fitting regression lines for TS versus the logs of *ka*, length (*L*), wet weight (WW), and dry weight (DW). Contrary to an empirical model derived from similar experiments (Wiebe et al. 1990), and to the high-pass models, the regressions indicated that TS is proportional to the cross-sectional area of the animal. However, because scattering from individual zooplankton is highly nonlinear, especially in the geometric scattering region (*ka*>1), linear regressions of TS versus the log of *ka*, L, WW, or DW can be misleading. Furthermore, neither Wiebe et al. (1990) nor this experiment directly accounted for animal orientations. Simulations using a distorted-wave Born-approximation model (Chu et al. 1993) indicated that animal behavior is an important factor in the scattering characteristics of zooplankton. Different distributions of animal tilt angle can influence the general trend of the TS model to exhibit either areal or near volumetric dependence.

Dutton, P., and G. H. Balazs. 1995. Simple biopsy technique for sampling skin for DNA analysis of sea turtles. Mar. Turt. Newsl. 69:6-9.

Eldridge, M. B., and B. M. Jarvis. 1995. Temporal and spatial variation in fecundity of yellowtail rockfish. Trans. Am. Fish. Soc. 124(1):16-25.

Fecundities of the commercially important yellowtail rockfish, *Sebastes flavidus*, were compared to determine interannual variability and geographic variation, which will assist in stock assessment, characterization, and management. Gravimetrically estimated fecundities were compared in 1985-1991 between California, the southern extent of the species' distribution, and coastal waters of Washington, near the center of the species' abundance, where yellowtail rockfish are most heavily fished. California yellowtail rockfish were older, smaller in weight and length, and had smaller mesenteric fat deposits and more extensive disease and parasite pathologies than Washington fish. Egg production of this comparatively fecund viviparous fish increased linearly and sigmoidally with body weight and length, and asymptotically with age. Significant interannual differences were found in fecundities of young fish (<age 15) from California while no differences were observed in older California fish (>age 14) or in young or old Washington fish. Washington yellowtail rockfish had higher group fecundities because they were larger at age. Rate-specific fecundities were significantly higher in young Washington fish. Predictive models of fecundity were highly correlated for young yellowtail rockfish, less so for old fish. Although fecundity of young fish depended on weight, length, and age, that of old fish was age-independent. The authors' findings show age-dependent interannual and geographic differences in reproductive effort, which suggest population-specific reproductive life histories.

Fraga, S., and A. Bakun. 1993. Global climate change and harmful algal blooms: the example of *Gymnodinium catenatum* on the Galician coast. *In* T. J. Smayda and Y. Shimizu (eds.), Toxic Phytoplankton Blooms in the Sea. Elsevier Science Publishers B.V.

A scenario is presented in which the incidence of blooms of the toxic dinoflagellate *Gymnodinium catenatum* on the coast of northwestern Galicia (Spain) could increase due to global climate change. Blooms of *G. catenatum* in the Galician ria appear to be related to the autumn relaxation of upwelling. This results in the incursion of warm, nutrient depleted surface water into the rias, deepening the nutricline. Being a chain-former, *G. catenatum* is an effective swimmer and better adapted to vertical migration than other dinoflagellates. Thus, a deepening of the nutricline may favor this species which is capable of migrating to the deep layers to take up nutrients. It is expected that atmospheric "greenhouse" effects will intensify equatorward wind stress along the west coast of the Iberian Peninsula during spring and summer, thereby amplifying coastal upwelling. This would increase the

temperature difference between recently upwelled waters and surface waters of oceanic origin and enhance primary production and mussel growth within the rias during summer. The estuarine circulation of the rias would then export increased particulate organic matter (phytoplankton and mussel feces) from the rias. This organic matter would tend to settle and remineralize on the continental shelf near the mouth of the rias, increasing the nutrient concentration of the waters entering the rias below the nutricline. The combination, during fall, of increased nutrient concentrations below a deepened nutricline and a more strongly stratified water column would seem to be particularly favorable to *G. catenatum*. The first recorded observation of this species was in 1976 when the first paralytic shellfish poisoning outbreak associated with Galician bivalves was also reported. Conversely, *Gonyaulax polyedra*, a common bloom species in the past, is now rare in the rias.

Graczyk, T. K., A. A. Aguirre, and G. H. Balazs. 1995. Detection by ELISA of circulating anti-blood fluke (*Carettacola, Hapalotrema*, and *Learedius*) immunoglobulins in Hawaiian green turtles (*Chelonia mydas*). J. Parasitol. 81(3):416-421.

An enzyme-linked immunosorbent assay (ELISA) is described utilizing the surface glycolax crude antigen of adult blood trematodes *Learedius learedi, Hapalotrema dorsopora*, and *Carettacola hawaiiensis*, for the detection of circulating antibodies (Ab) in Hawaiian green turtles (*Chelonia mydas*) naturally infected with the parasites and with or without green turtle fibropapillomatosis (GTFP). A concentration of 10.0 µg/ml of antigen was optimal in terms of test specificity and sensitivity. A direct ELISA with anti-reptilian/amphibian phosphatase-labeled IgG identified *C. mydas* Ab at a dilution of 1/12,800. Utilizing indirect ELISA, it was possible to detect Ab to blood flukes at a dilution of 1/3,200. The gross lesions and histopathology were typical for cardiovascular spirorchidiasis in *C. mydas*. No significant relationship was found between the size of turtles and the degree of GTFP severity. Forty-seven of 59 (80%) samples, from 5 sites, gave a positive ELISA reaction: 6 of the 47 (13%) specimens gave significantly ($P < 0.0001$) higher absorbance values, with 5 from the same location. All 12 (20%) ELISA-negative turtles originated from one site, and the absorbance values of the 41 animals from this location were significantly lower ($P < 0.015$) when compared with the other four sites. The proposed assay is fast, has the feature of visual scoring, and can be used for determination of exposure of *C. mydas* to the spirorchid trematodes.

Hobson, E. S., J. R. Chess, and D. F. Howard. 1995. Anomalous damage inflicted by Hurricane Iniki on a Hawaiian coral reef. Bull. Mar. Sci. 57(2):495-500.

Although effects of hurricanes on coral reefs have been well documented, damage inflicted by Hurricane Iniki on a Hawaiian reef composed mainly of the poritid scleractinian *Porites compressa* suggests processes not yet described. This reef on the lee side of the island of Hawaii slopes gently seaward to a depth of about 12 m, then steeply to sand at about 25 m. While prevailing opinion states that storm effects decrease with depth, Iniki exerted its major effect below 16 m on this reef's steep outer slope. There a swath of total destruction extended about 50 m along the reef face, but there was little damage to the coral immediately above. An examination of *P. compressa* from different depths showed a trend from stubby, closely spaced branches in the shallows, to elongate, more widely spaced branches in deeper water. Also, at progressively greater depths the coral was less resistant to breakage and movement. These characteristics are judged adaptations to the strength and frequency of hydraulic energy generated by past storms. It is concluded that the destruction below 16 m represents the reef's historical lack of exposure to, and therefore inability to accommodate, levels of hydraulic energy generated by storms as severe as Iniki.

Jacobson, L. D., and A. D. MacCall. 1995. Stock-recruitment models for Pacific sardine. Can. J. Fish. Aquat. Sci. 52:566-577.

Generalized additive models were used to study the recruitment of Pacific sardine (*Sardinops sagax*) along western North America and to compare the effects of fishing and environmental factors on the stock. Significant relationships were found between the logarithm of sardine reproductive success (recruits per unit of spawning biomass) and average sea surface temperature (SST), as well as between sardine recruitment, spawning biomass, and average SST. Simulation and time series analyses were used to evaluate bias, variance, and statistical power for one model. Correlation with log reproductive success was highest when average SST data included temperatures after the period of larval development, indicating that recruitment estimates were affected by environmentally driven changes in availability of older sardine to the fishery. Predicted equilibrium biomass and maximum sustainable yield for sardine are lower under environmental conditions that prevail when temperatures are colder. Long-term fluctuations in the environment may cause long-term fluctuations in sardine productivity, and little or no sardine harvest may be sustainable during periods of adverse environmental conditions and cold temperatures.

Kleiber, P., and J. Hampton. 1994. Modeling effects of FADs and islands on movement of skipjack tuna (*Katsuwonus pelamis*): estimating parameters from tagging data. Can. J. Fish. Aquat. Sci. 51:2642-2653.

From an experiment with ordinary dart tags, evidence was found of the effect of fish aggregating devices (FADs) and of islands on the movements of skipjack tuna (*Katsuwonus pelamis*) around the Solomon Islands. By fitting a fish movement model to the tag data, the authors were able to estimate mortality and movement parameters (including diffusivity), parameters of a function that models FAD attraction, and a sepa-

rate parameter of island attraction. Diffusivity was high enough to effectively distribute fish throughout the island archipelago (approximately 150,000 km^2) within a few months. Estimates of FAD parameters indicate that the presence of up to four or five FADs in an area approximately 50 x 50 km can reduce the propensity for skipjack to leave that area by approximately 50%, but that deploying additional FADs in such an area does not significantly increase their effectiveness in holding skipjack. Estimates of the island attraction parameter imply that the propensity of skipjack for movement away from the archipelago is less than half the propensity for movement within it.

Kobayashi, D. R., and K. E. Kawamoto. 1995. Evaluation of shark, dolphin, and monk seal interactions with Northwestern Hawaiian Island bottomfishing activity: a comparison of two time periods and an estimate of economic impacts. Fish. Res. 23:11-22.

The incidence rates of bottomfish damaged by sharks, dolphins, and monk seals were compared from two sources of observer data taken aboard commercial bottomfishing vessels in the Northwestern Hawaiian Islands. The current (1990-1993) shark damage rate is significantly different from, and nearly six times higher than, the rate measured in 1981-1982. The dolphin and monk seal damage rates are also currently higher than the earlier rates. These temporal differences could be indicative of an increasing trend in interaction rates. A theoretical model is developed to estimate unobservable losses of fish based on the amount of fishing gear lost. The current economic impact is estimated to be approximately $700,000 annually (or approximately $7,000 of lost revenue per trip on average) considering all sources of losses.

Laidig, T. E., and S. Ralston. 1995. The potential use of otolith characters in identifying larval rockfish (*Sebastes* spp.). Fish. Bull. 93:166-171.

Norton, E. C., and R. B. MacFarlane. 1995. Nutritional dynamics of reproduction in viviparous yellowtail rockfish (*Sebastes flavidus*). Fish. Bull. 93:299-307.

Nutritional dynamics of yellowtail rockfish, *Sebastes flavidus*, were analyzed from the perspective of temporal changes in tissue composition of liver, muscle, mesentery, and gonad to determine aspects specific to female reproduction. Monthly tissue composition data over an annual reproductive cycle indicated that females accumulated greater somatic tissue energy reserves than did males during the summer and fall months. Maternal lipid and protein reserves were depleted in a reciprocal relation with ovarian growth during the winter. The greatest declines of lipid and protein occurred in mesenteries and muscle, respectively. Females lost approximately 40% more somatic tissue than males during the time interval from ovarian development to parturition. Lipid was the primary energy source, contributing 74% of the energy lost from somatic tissues for female-specific reproductive purposes. Two-thirds of lipid depleted from maternal soma was for adult metabolic maintenance. Of the other one-third, 43% was gained in ovary tissue during development, leaving 57% for reproductive metabolic costs. Protein increased 220% in ovaries relative to female-specific somatic protein loss, indicating de novo ovarian synthesis. This study is the first report of comprehensive tissue composition dynamics and allocation to reproduction in a viviparous marine teleost. The analytical design used demonstrated the significance of each tissue component and the temporal pattern of allocation to reproductive development.

Papadi, G. P., G. H. Balazs, and E. R. Johnson. 1995. Flow cytometric DNA content analysis of fibropapillomas in green turtles (*Chelonia mydas*). Dis. Aquat. Org. 22:13-18.

In an attempt to characterize biologic properties of green turtle fibropapillomatosis (GTFP), blood cells, dermis of normal skin, dermis of cutaneous fibropapillomas, and visceral fibroblastic nodules of green turtles, *Chelonia mydas*, with cutaneous fibropapilloma were examined by flow cytometry. DNA of each sample was stained with propidium iodide and histograms were recorded utilizing a FACSCAN flow cytometer. All samples examined had similar histograms, indicative of normal cell cycles and diploid profiles. Small S phase and G^{2M} fractions (<5%) indicated a low mitotic activity and a nonproliferating state. Statistical analyses were performed on the coefficient of variation (CV) of the G^1 peak for the various tissues analyzed. The mean CV for blood from all the unaffected turtles was 3.21 while that from turtles afflicted with GTFP was 4.25 and 4.41, respectively. The mean CV for fibropapillomas was 5.27, a number which, though higher than either blood or normal skin, probably reflects the difference in stain uptake characteristics between fibropapillomas and the other two tissues rather than any inherent DNA or ploidy difference.

Parrish, R. H., and D. L. Mallicoate. 1995. Variation in the condition factors of California pelagic fishes and associated environmental factors.

Time series of condition factors for mackerel, jack mackerel, and northern anchovy stocks in the southern California region were compared to time series of oceanographic indices to develop hypotheses concerning physical environmental forcing of the population dynamics and energetics of small pelagic fishes. Mackerel and jack mackerel condition factor time series showed decade-scale variation, whereas those of anchovy showed coherent fluctuations for 1 to 2 years. Mackerel, and to a lesser extent jack mackerel, condition factors were correlated with proxy indices of along shore advection (sea level), offshore advection (Ekman transport), ambient temperature (shore station temperature), and ambient salinity (shore station salinity). The condition factor of anchovy was much less correlated with environmental variables. Multiple regression analyses, which included sea level, up-

welling, and salinity proxies, explained 80% (33%) of the variance in the annual (monthly) condition factor of mackerel. The first order variation in condition factors of mackerel and jack mackerel suggests that they are responding to very large-scale perturbations of the California Current system which are at least partially described by variations in sea level. The population size of mackerel is apparently also responding to these large-scale perturbations, making it difficult to isolate environmental dependence of condition factors from density dependence. The second order variation is more regional in nature and unexpectedly it appears to be associated with upwelling in the Baja California region.

Pitman, R. L., L. B. Spear, and M. P. Force. 1995. The marine birds of Malpelo Island, Colombia. Colon. Waterbirds 18(1):113-119.

Information is presented on the status of the breeding sea birds of Malpelo Island, located 500 km off the Pacific coast of Colombia, based on six visits to the island from 1985 to 1992. The distinctive orange-billed form of the Masked Booby, *S. dactylatra granti*, which is apparently endemic to the eastern Pacific Ocean, is by far the island's most abundant breeding sea bird. Using aerial photography, an accurate population estimate of 24,034 individuals was obtained, making this the second largest Masked Booby colony in the world. The only other species definitely known to breed at Malpelo is Swallow-tailed Gull, *Creagrus furcatus*, with an estimated 50 pairs. Other species that regularly occur at Malpelo and probably breed in small numbers include: Red-billed Tropicbird, *Phaethon aethereus*, Red-footed Booby, *Sula sula*, Black Noddy, *Anous minutus*, Brown Noddy, *A. stolidus*, and White Tern, *Gygris alba*. Great and Magnificent Frigatebirds, *Frigate minor* and *F. magnificens*, are present year-round and may also breed. Malpelo was uninhabited until 1986 when a small military garrison was established, which raises concern about the possibility of introduced pests.

Polovina, J. J., W. R. Haight, R. B. Moffitt, and F. A. Parrish. 1995. The role of benthic habitat, oceanography, and fishing on the population dynamics of the spiny lobster (*Panulirus marginatus*) in the Hawaiian Archipelago. Crustaceana 68(2):203-212.

Rabour, C. O., and J. J. Polovina. 1995. An analysis of the multigear, multispecies fishery in the Kenyan waters of Lake Victoria. Naga 18(2):34-37.

Catch rates in both Nile perch, *Lates niloticus*, and dagaa, *Rastrineobola argentea*, from Kenyan waters of Lake Victoria have steadily increased through the 1980s, even though fishing effort also increased during the same period. However, analysis of catch and effort data within and outside the Nyanza Gulf suggests an increase in catch rates in the offshore region, rather than an increase in abundance. Analyses of catch rates by gear type both in and outside the Nyanza Gulf show that 1991 catch rates are lower than 1989 levels — by 60-80% in some instances. Since the fishing power of these gears has increased during this period, it is likely that fish abundance declined more than catch rates. A dynamic population model is used to simulate Nile perch dynamics. It indicates that a decline in catches should be anticipated.

Sakuma, K. M., and R. J. Larson. 1995. Distribution of pelagic metamorphic-stage sanddabs *Citharichthys sordidus* and *C. stigmaeus* within areas of upwelling off central California. Fish. Bull. 93:516-529.

Upwelling and its associated offshore advection of surface waters can affect the recruitment of nearshore organisms. Late-stage pelagic Pacific and speckled sanddabs, *Citharichthys sordidus* and *C. stigmaeus*, were collected with a midwater trawl off central California during the spring and summer upwelling season. In both species, otolith size increased linearly with metamorphic development; standard length, however, increased asymptotically. Earlier stages of both species occurred shallower in the water column, whereas later stages occurred deeper. The deeper distribution of later stages may have been due to decreased buoyancy as a result of increased otolith size and ossification of bony structures coincident with metamorphosis. Earlier stages of both species were more abundant offshore and less abundant in areas of upwelling, whereas later stages were more abundant nearshore regardless of upwelling. The difference in the horizontal distributions of early and late stages may have been passively driven by different current patterns as a result of the difference in vertical distributions between early and late stages.

Salvanes, K. G., and D. Squires. 1995. Transferable quotas, enforcement costs and typical firms: an empirical application to the Norwegian trawler fleet. Environ. Resource Econ. 6:1-12.

An alternative to traditional regulation of fisheries to avoid rent dissipation is the use of individual transferable quotas (ITQs) where prices in the quota market provide the necessary information to owners of harvest rights to contract with each other. However, even under such a decentralized regime, information on the underlying technology of the fishing vessels is also necessary. First, since most fisheries consist of many interrelated production processes, to avoid rent dissipation by discarding wrong output mix, and so forth, the structure of production in the multispecies fishery must be known to design a proper quota system. Second, an ITQ system may create incentives for misreporting by understating the actual catch. This may especially be the case where the expected degree of self-enforcement is low. The authors propose a way to reduce the information requirements under regulation with asymmetric information by constructing a typical firm and comparing performance for the other vessels to this firm. Based on the typical firm, and if the industry is relatively homogenous, the performance and hence catch of any other firm in the industry can be predicted within a certain range. Further, this idea

is applied to the Norwegian trawler fleet to assess the production structure in terms of jointness, input-output separability, and the supply and demand elasticities for the fishing firms. This information characterizes the fishery and thus how the quota system may be designed and how to construct a yardstick in order to reduce the enforcement cost under a decentralized regulation of ITQs.

Squires, D., and J. Kirkley. 1995. Resource rents from single and multispecies individual transferable quota programs. ICES J. mar. Sci. 52:153-164.

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Approved by Science and Research Director, SWR

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